2 OUTPUT PCIE GEN1/2 SYNTHESIZER

Recommended Applications

2 output synthesizer for PCIe Gen1/2 and Ethernet

General Description

The IDT5V41285 is a PCIe Gen2 compliant clock generator. The device has 2 differential HCSL outputs. The output frequency is selectable via select pins.

Output Features

- 2 - Non-spread 0.7V current mode differential HCSL output pairs

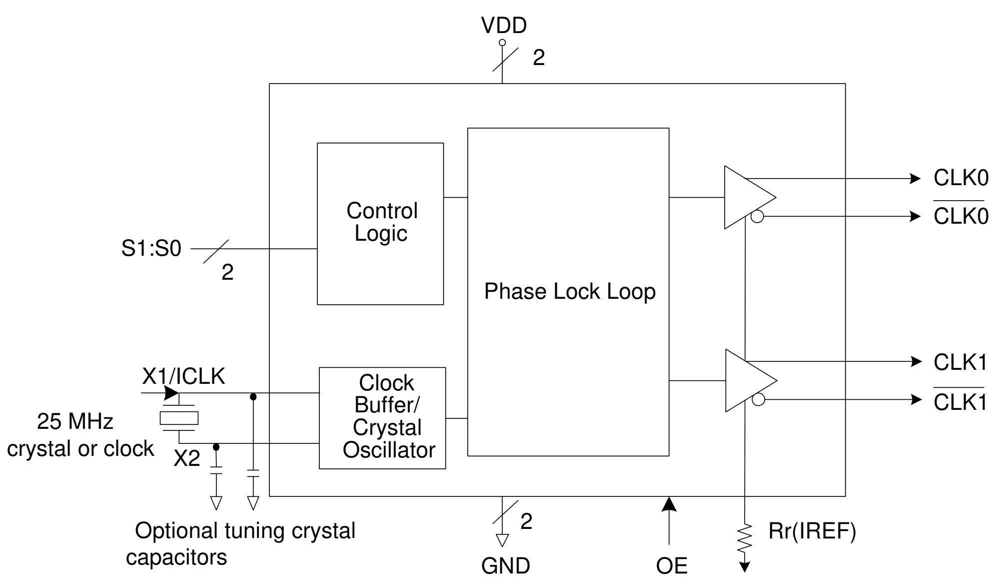
Features/Benefits

- 16-pin TSSOP and VFQFPN packages; small board footprint
- Outputs can be terminated to LVDS; can drive a wider variety of devices
- OE control pin; greater system power management
- Industrial temperature range available; supports demanding embedded applications
- **For PCIe Gen3 applications, see the IDT5V41315**

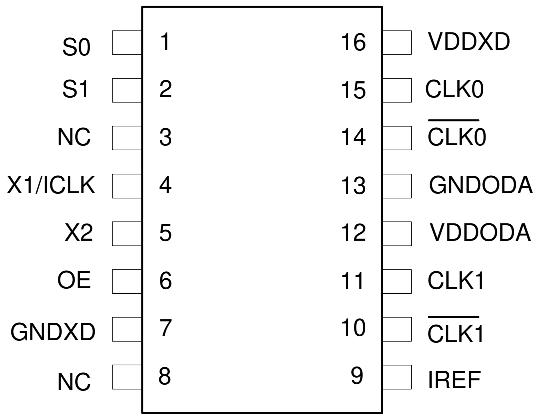
Key Specifications

- Cycle-to-cycle jitter: 80ps
- Output-to-output skew <50 ps
- PCIe Gen2 phase jitter <3.0ps RMS
- Low phase noise: 12kHz to 20MHz <6ps

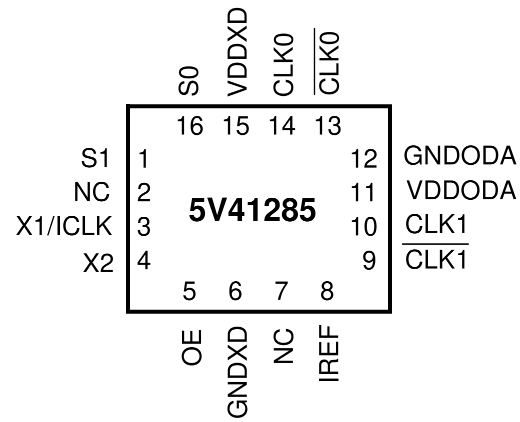
Block Diagram



Pin Assignment



16-pin (173 mil) TSSOP



16-pin VFQFPN

Output Select Table 1 (MHz)

S1	S0	CLK(1:0), $\overline{\text{CLK(1:0)}}$
0	0	25M
0	1	100M
1	0	125M
1	1	200M

Pin Descriptions

VFQFP Pin Number	TSSOP Pin Number	Pin Name	Pin Type	Pin Description
16	1	S0	Input	Select pin 0. See Output Select Table 1. Internal pull-up resistor.
1	2	S1	Input	Select pin 1. See Output Select Table 1. Internal pull-up resistor.
2	3	NC	–	No connect.
3	4	X1/ICLK	Input	Crystal or clock input. Connect to a 25 MHz crystal or single ended clock.
4	5	X2	Output	Crystal connection. Leave unconnected for clock input.
5	6	OE	Input	Output enable. Tri-states outputs and device is not shut down. Internal pull-up resistor.
6	7	GNDXD	Power	Connect to ground.
7	8	NC	–	No connect.
8	9	IREF	Output	Precision resistor attached to this pin is connected to the internal current reference.
9	10	$\overline{\text{CLK1}}$	Output	HCSL complementary clock output 1.
10	11	CLK1	Output	HCSL true clock output 1.
11	12	VDDODA	Power	Connect to voltage supply +3.3 V for output driver and analog circuits
12	13	GNDODA	Power	Connect to ground.
13	14	$\overline{\text{CLK0}}$	Output	HCSL complementary clock output 0.
14	15	CLK0	Output	HCSL true clock output 0.
15	16	VDDXD	Power	Connect to voltage supply +3.3 V for crystal oscillator and digital circuit.

Applications Information

External Components

A minimum number of external components are required for proper operation.

Decoupling Capacitors

Decoupling capacitors of 0.01 µF should be connected between each VDD pin and the ground plane, as close to the VDD pin as possible. Do not share ground vias between components. Route power from power source through the capacitor pad and then into ICS pin.

Crystal

A 25 MHz fundamental mode parallel resonant crystal should be used. This crystal must have less than 300 ppm of error across temperature in order for the IDT5V41285 to meet PCI Express specifications.

Crystal Capacitors

Crystal capacitors are connected from pins X1 to ground and X2 to ground to optimize the accuracy of the output frequency.

C_L= Crystal's load capacitance in pF

Crystal Capacitors (pF) = (C_L- 8) * 2

For example, for a crystal with a 16 pF load cap, each external crystal cap would be 16 pF. (16-8)*2=16.

Current Source (Iref) Reference Resistor - R_R

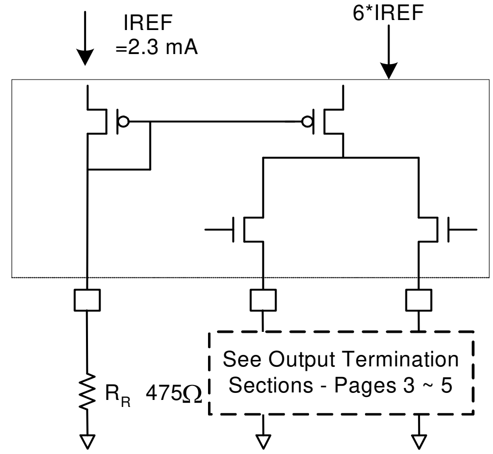
If board target trace impedance (Z) is 50Ω, then R_R = 475Ω (1%), providing IREF of 2.32 mA. The output current (I_{OH}) is equal to 6*IREF.

Output Termination

The PCI-Express differential clock outputs of the IDT5V41285 are open source drivers and require an external series resistor and a resistor to ground. These resistor values and their allowable locations are shown in detail in the **PCI-Express Layout Guidelines** section.

The IDT5V41285 can also be configured for LVDS compatible voltage levels. See the **LVDS Compatible Layout Guidelines** section.

Output Structures



General PCB Layout Recommendations

For optimum device performance and lowest output phase noise, the following guidelines should be observed.

1. Each 0.01µF decoupling capacitor should be mounted on the component side of the board as close to the VDD pin as possible.

2. No vias should be used between decoupling capacitor and VDD pin.

3. The PCB trace to VDD pin should be kept as short as possible, as should the PCB trace to the ground via. Distance of the ferrite bead and bulk decoupling from the device is less critical.

4. An optimum layout is one with all components on the same side of the board, minimizing vias through other signal layers (any ferrite beads and bulk decoupling capacitors can be mounted on the back). Other signal traces should be routed away from the IDT5V41285.This includes signal traces just underneath the device, or on layers adjacent to the ground plane layer used by the device.

Layout Guidelines

SRC Reference Clock			
Common Recommendations for Differential Routing	Dimension or Value	Unit	Figure
L1 length, route as non-coupled 50ohm trace	0.5 max	inch	1
L2 length, route as non-coupled 50ohm trace	0.2 max	inch	1
L3 length, route as non-coupled 50ohm trace	0.2 max	inch	1
Rs	33	ohm	1
Rt	49.9	ohm	1

Down Device Differential Routing			
L4 length, route as coupled microstrip 100ohm differential trace	2 min to 16 max	inch	1
L4 length, route as coupled stripline 100ohm differential trace	1.8 min to 14.4 max	inch	1

Differential Routing to PCI Express Connector			
L4 length, route as coupled microstrip 100ohm differential trace	0.25 to 14 max	inch	2
L4 length, route as coupled stripline 100ohm differential trace	0.225 min to 12.6 max	inch	2

Figure 1: Down Device Routing

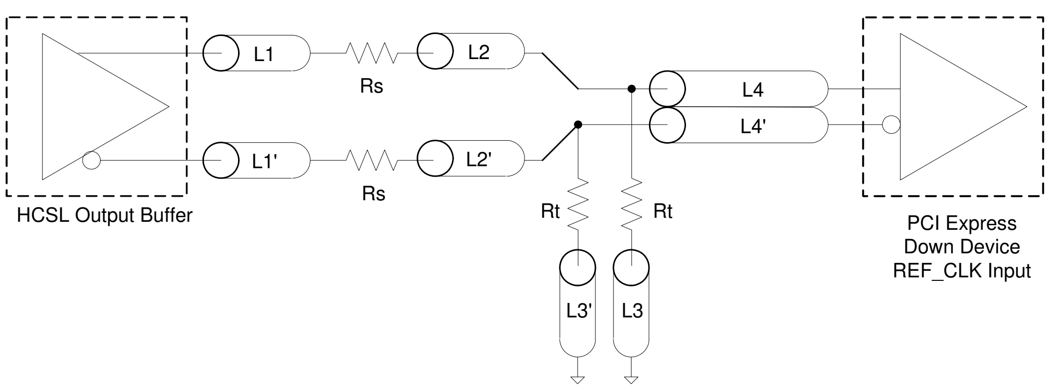
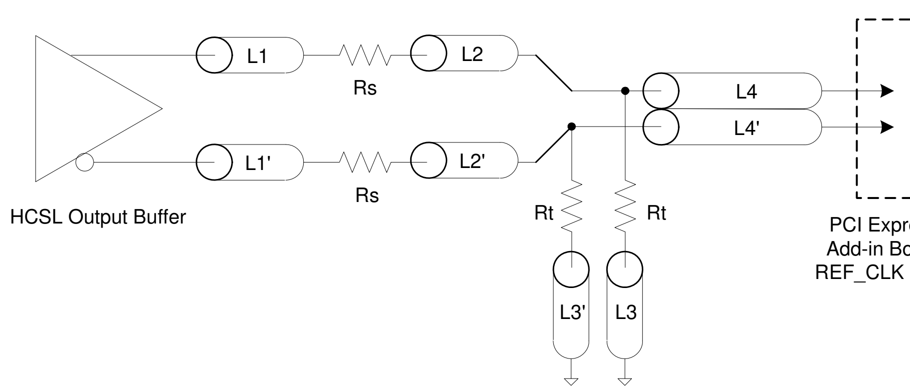


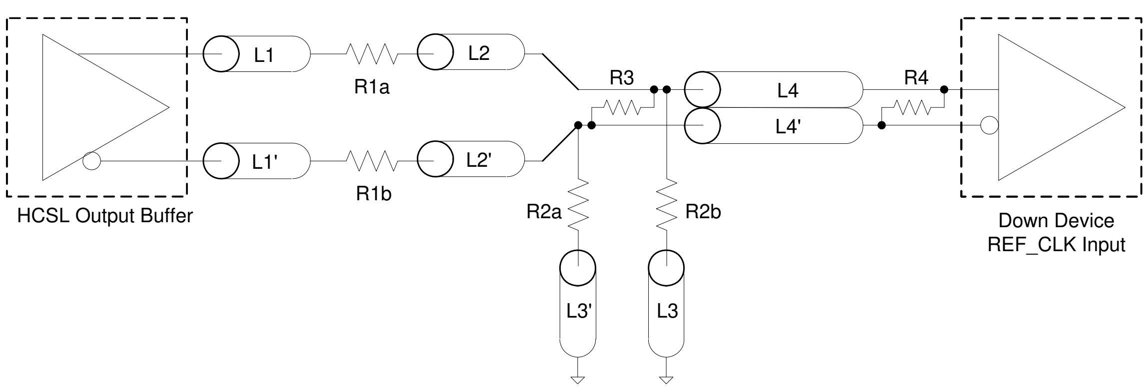
Figure 2: PCI Express Connector Routing



Alternative Termination for LVDS and other Common Differential Signals (figure 3)							
Vdiff	Vp-p	Vcm	R1	R2	R3	R4	Note
0.45v	0.22v	1.08	33	150	100	100	
0.58	0.28	0.6	33	78.7	137	100	
0.80	0.40	0.6	33	78.7	none	100	ICS874003i-02 input compatible
0.60	0.3	1.2	33	174	140	100	Standard LVDS

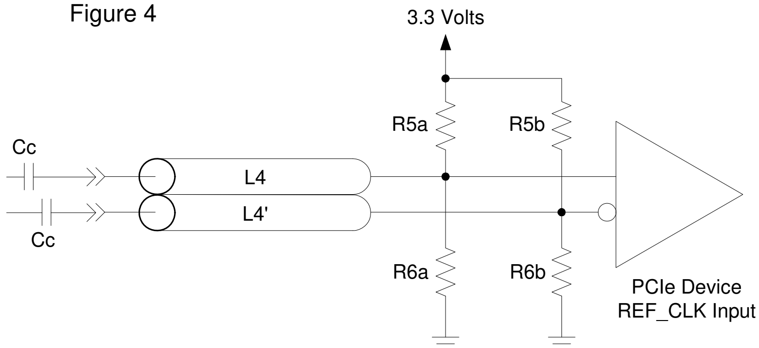
R1a = R1b = R1
R2a = R2b = R2

Figure 3

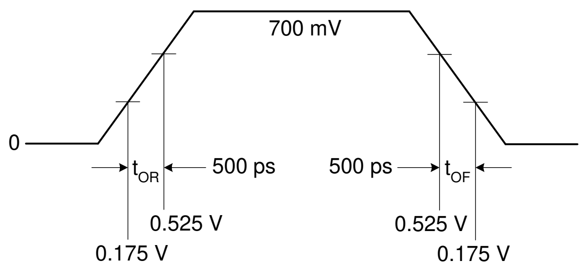


Cable Connected AC Coupled Application (figure 4)		
Component	Value	Note
R5a, R5b	8.2K 5%	
R6a, R6b	1K 5%	
Cc	0.1 µF	
Vcm	0.350 volts	

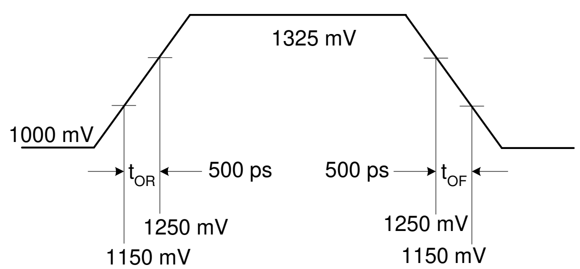
Figure 4



Typical PCI-Express (HCSL) Waveform



Typical LVDS Waveform



Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the IDT5V41285. These ratings are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

Item	Rating
Supply Voltage, VDDXD, VDDODA	4.6 V
All Inputs and Outputs	-0.5 V to VDD+0.5 V
Ambient Operating Temperature (commercial)	0 to +70°C
Ambient Operating Temperature (industrial)	-40 to +85°C
Storage Temperature	-65 to +150°C
Junction Temperature	125°C
Soldering Temperature	260°C
ESD Protection (Input)	2000 V min. (HBM)

DC Electrical Characteristics

Unless stated otherwise, **VDD = 3.3 V ±5%**, Ambient Temperature -40 to +85°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Supply Voltage	V		3.135	3.3	3.465	V
Input High Voltage[1]	V_{IH}	S0, S1, OE, ICLK	2.2		VDD +0.3	V
Input Low Voltage[1]	V_{IL}	S0, S1, OE, ICLK	VSS-0.3		0.8	V
Input Leakage Current[2]	I_{IL}	0 < Vin < VDD	-5		5	μA
Operating Supply Current @100 MHz	I_{DD}	R_S=33Ω, R_P=50Ω, C_L=2 pF		63	85	mA
	I_{DDOE}	OE =Low		42	50	mA
Input Capacitance	C_{IN}	Input pin capacitance			7	pF
Output Capacitance	C_{OUT}	Output pin capacitance			6	pF
X1, X2 Capacitance	C_{INX}				5	pF
Pin Inductance	L_{PIN}				5	nH
Output Impedance	Z_O	CLK outputs	3.0			kΩ
Pull-up Resistor	R_{PU}	S0, S1, OE		100		kΩ

1. Single edge is monotonic when transitioning through region.
2. Inputs with pull-ups/-downs are not included.

AC Electrical Characteristics - CLK0/CLK1, $\overline{\text{CLK0/CLK1}}$

Unless stated otherwise, VDD=3.3 V ±5%, Ambient Temperature -40 to +85°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Frequency				25		MHz
Output Frequency		HCSL termination	25		200	MHz
		LVDS termination	25		100	MHz
Output High Voltage[1,2]	V_{OH}	HCSL			850	mV
Output Low Voltage[1,2]	V_{OL}	HCSL	-150			mV
Crossing Point Voltage[1,2]		Absolute	250		550	mV
Crossing Point Voltage[1,2,4]		Variation over all edges			140	mV
Jitter, Cycle-to-Cycle[1,3]					80	ps
Frequency Synthesis Error		All outputs		0		ppm
Rise Time[1,2]	t_{OR}	From 0.175 V to 0.525 V	175		700	ps
Fall Time[1,2]	t_{OF}	From 0.525 V to 0.175 V	175		700	ps
Rise/Fall Time Variation[1,2]					125	ps
Output to Output Skew					50	ps
Duty Cycle[1,3]			45		55	%
Output Enable Time[5]		All outputs		50	100	ns
Output Disable Time[5]		All outputs		50	100	ns
Stabilization Time	t_{STABLE}	From power-up VDD=3.3 V			1.8	ms

Note 1: Test setup is R_S=33Ω, R_P=50Ω with C_L=2 pF, Rr = 475Ω (1%).

Note 2: Measurement taken from a single-ended waveform.

Note 3: Measurement taken from a differential waveform.

Note 4: Measured at the crossing point where instantaneous voltages of both CLK and $\overline{\text{CLK}}$ are equal.

Note 5: CLK pins are tri-stated when OE is low asserted. CLK is driven differential when OE is high.

Electrical Characteristics - Differential Phase Jitter

Parameter	Symbol	Conditions	Min	Typ	Max	Units	Notes
Jitter, Phase	$t_{jphasePLL}$	PCIe Gen1		32	86	ps (p-p)	1,2
	$t_{jphaseLO}$	PCIe Gen2, 10 kHz < f < 1.5 MHz		0.8	3	ps (RMS)	1,2
	$t_{jphaseHIGH}$	PCIe Gen2, 1.5 MHz < f < Nyquist (50 MHz)		2.3	3.1	ps (RMS)	1,2

Note 1. Guaranteed by design and characterization, not 100% tested in production.

Note 2. See http://www.pcisig.com for complete specs.

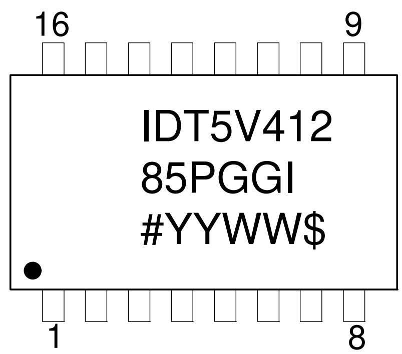
Thermal Characteristics (16-TSSOP)

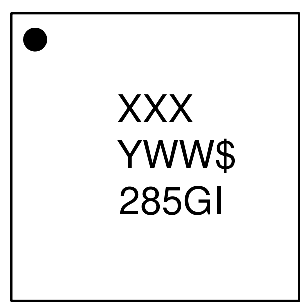
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	θ_{JA}	Still air		78		°C/W
	θ_{JA}	1 m/s air flow		70		°C/W
	θ_{JA}	3 m/s air flow		68		°C/W
Thermal Resistance Junction to Case	θ_{JC}			37		°C/W

Thermal Characteristics (16-VFQFPN)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Thermal Resistance Junction to Ambient	θ_{JA}	Still air		63.2		°C/W
	θ_{JA}	1 m/s air flow		55.9		°C/W
	θ_{JA}	3 m/s air flow		51.4		°C/W
Thermal Resistance Junction to Case	θ_{JC}			65.8		°C/W

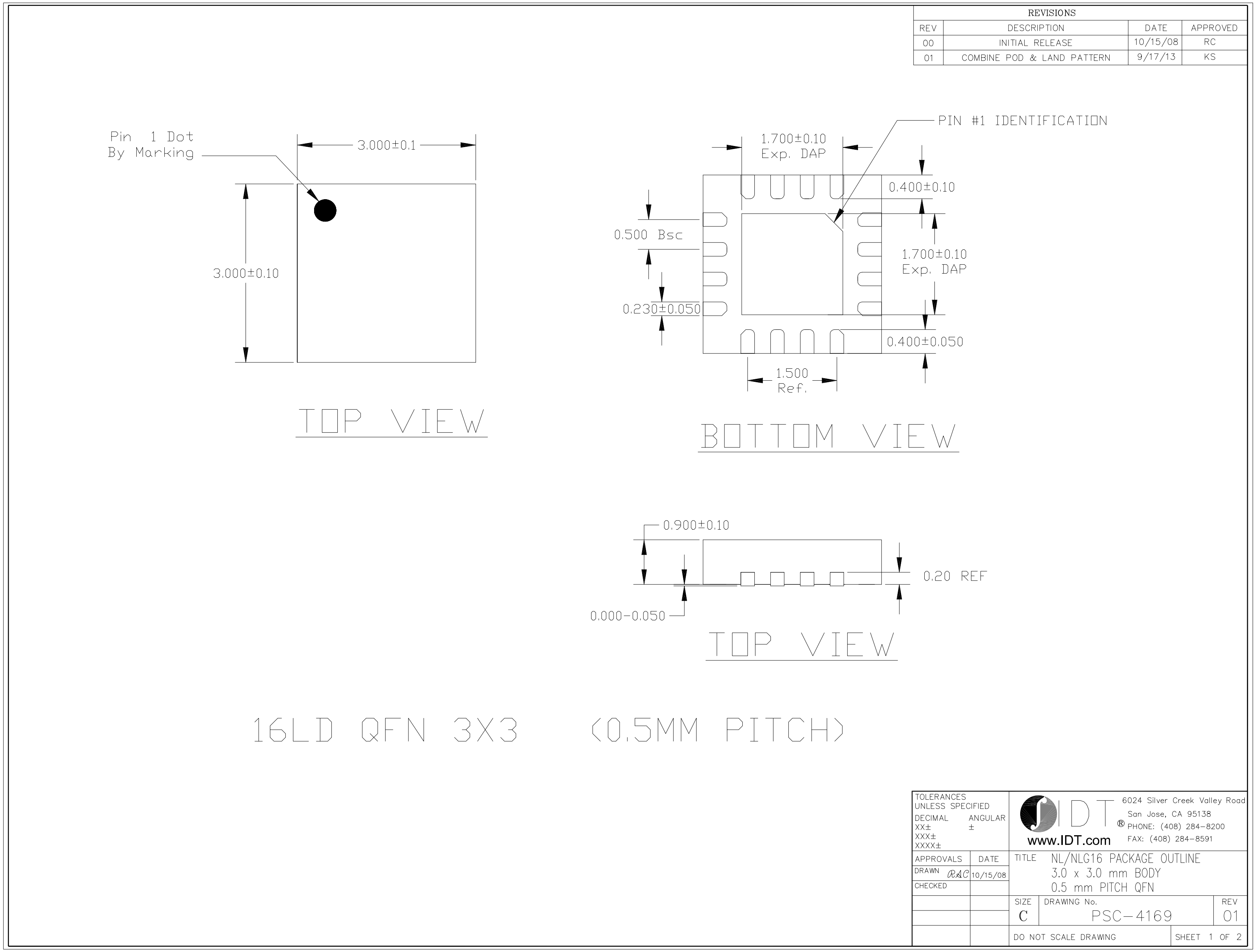
Marking Diagrams





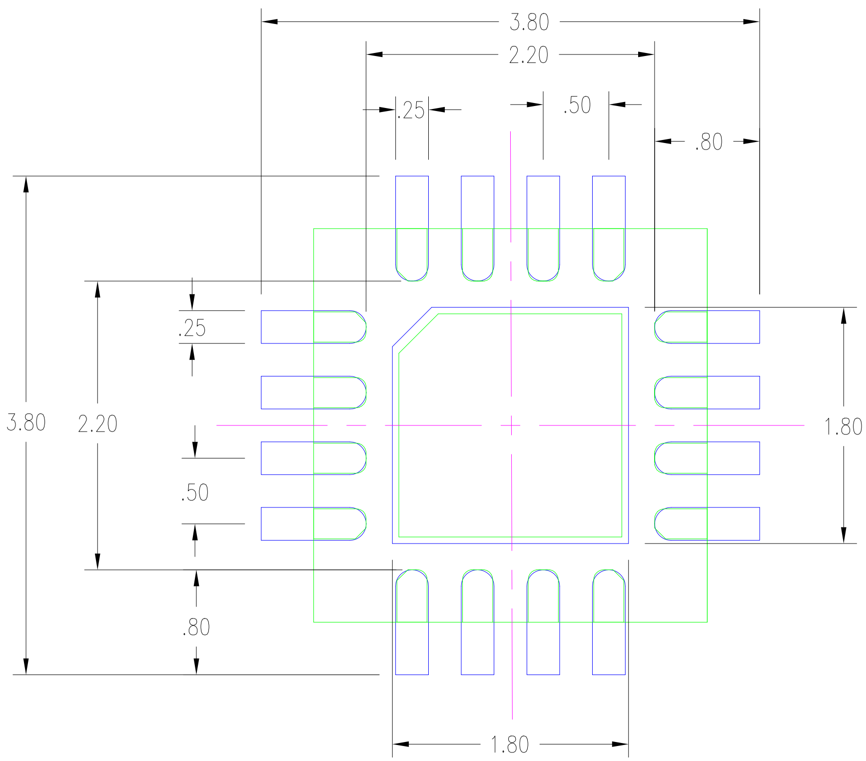
Notes:
1. Line 1 and 2: IDT part number.
2. Line 3: # – Die revision; YYWW – Date code; $–Assembly location.
3. “G” after the two-letter package code designates RoHS compliant package.
4. “I” at the end of part number indicates industrial temperature range.
5. Bottom marking: country of origin if not USA (TSSOP only).

Package Outline and Dimensions (3 x 3mm 16-VFQFPN)



Package Outline and Dimensions (3 x 3mm 16-VFQFPN), cont.

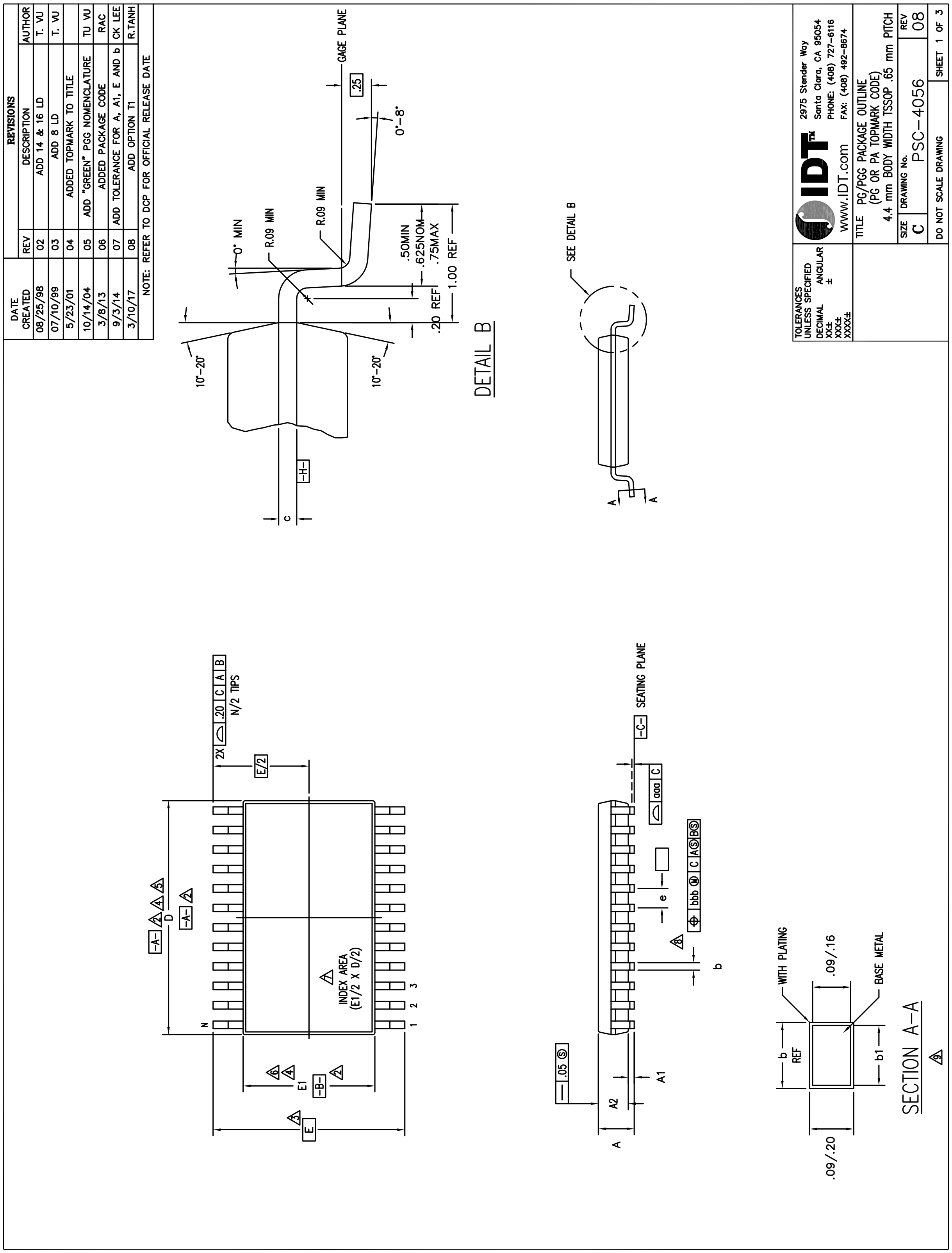
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
00	INITIAL RELEASE	10/15/08	RC
01	COMBINE POD & LAND PATTERN	9/17/13	KS



NOTES:
1. ALL DIMENSION ARE IN mm. ANGLES IN DEGREES.
2. TOP DOWN VIEW. AS VIEWED ON PCB.
3. COMPONENT OUTLINE SHOW FOR REFERENCE IN GREEN.
4. LAND PATTERN IN BLUE. NSMD PATTERN ASSUMED.
5. LAND PATTERN RECOMMENDATION PER IPC-7351B GENERIC REQUIREMENT FOR SURFACE MOUNT DESIGN AND LAND PATTERN.

TOLERANCES UNLESS SPECIFIED DECIMAL XX± XXX± XXXX± ANGULAR ±		IDT® www.IDT.com	6024 Silver Creek Valley Road San Jose, CA 95138 PHONE: (408) 284-8200 FAX: (408) 284-8591	
APPROVALS	DATE	TITLE	NL/NLG16 PACKAGE OUTLINE 3.0 x 3.0 mm BODY 0.5 mm PITCH QFN	
DRAWN RAC	10/15/08			
CHECKED				
		SIZE C	DRAWING No. PSC-4169	REV 01
		DO NOT SCALE DRAWING	SHEET 2 OF 2	

Package Outline and Dimensions (4.4 mm body, 16-TSSOP)



Package Outline and Dimensions (4.4 mm body, 16-TSSOP), cont.

DATE CREATED	REVISIONS REV	DESCRIPTION	AUTHOR
08/25/98	02	ADD 14 & 16 LD	T. VU
07/10/99	03	ADD 8 LD	T. VU
5/23/01	04	ADDED TOPMARK TO TITLE	
10/14/04	05	ADD "GREEN" PGG NOMENCLATURE	TU VU
3/8/13	06	ADDED PACKAGE CODE	RAC
9/3/14	07	ADD TOLERANCE FOR A, A1, E AND b	CK LEE
3/10/17	08	ADD OPTION T1	R.TANH
NOTE: REFER TO DCP FOR OFFICIAL RELEASE DATE			

SYMBOL	PG/PGG8 JEDEC VARIATION AA MIN	NOM	MAX	NOTE	PG/PGG14 JEDEC VARIATION AB-1 MIN	NOM	MAX	NOTE	PG/PGG16 JEDEC VARIATION AB MIN	NOM	MAX	NOTE
A	.85	1.10	1.20		.85	1.10	1.20		.85	1.10	1.20	
A1	.05	.10	.15		.05	.10	.15		.05	.10	.15	
A2	.80	1.00	1.05		.80	1.00	1.05		.80	1.00	1.05	
D	2.90	3.00	3.10	4,5	4.90	5.00	5.10	4,5	4.90	5.00	5.10	4,5
E	6.20	6.40	6.60	3	6.20	6.40	6.60	3	6.20	6.40	6.60	3
E1	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6
e		.65 BSC				.65 BSC				.65 BSC		
b	.19	.25	.30		.19	.25	.30		.19	.25	.30	
b1	.19	.22	.25		.19	.22	.25		.19	.22	.25	
aaa	–	–	.10		–	–	.10		–	–	.10	
bbb	–	–	.10		–	–	.10		–	–	.10	
N		8				14				16		

SYMBOL	PG/PGG20 JEDEC VARIATION AC MIN	NOM	MAX	NOTE	PG/PGG24 JEDEC VARIATION AD MIN	NOM	MAX	NOTE	PG/PGG28 JEDEC VARIATION AE MIN	NOM	MAX	NOTE
A	.85	1.10	1.20		.85	1.10	1.20		.85	1.10	1.20	
A1	.05	.10	.15		.05	.10	.15		.05	.10	.15	
A2	.80	1.00	1.05		.80	1.00	1.05		.80	1.00	1.05	
D	6.40	6.50	6.60	4,5	7.70	7.80	7.90	4,5	9.60	9.70	9.80	4,5
E	6.20	6.40	6.60	3	6.20	6.40	6.60	3	6.20	6.40	6.60	3
E1	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6	4.30	4.40	4.50	4,6
e		.65 BSC				.65 BSC				.65 BSC		
b	.19	.25	.30		.19	.25	.30		.19	.25	.30	
b1	.19	.22	.25		.19	.22	.25		.19	.22	.25	
aaa	–	–	.10		–	–	.10		–	–	.10	
bbb	–	–	.10		–	–	.10		–	–	.10	
N		20				24				28		

NOTES:

1 ALL DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M–1994

2 DATUMS -A- AND -B- TO BE DETERMINED AT DATUM PLANE -H-

3 DIMENSION E TO BE DETERMINED AT SEATING PLANE -C-

4 DIMENSIONS D AND E1 ARE TO BE DETERMINED AT DATUM PLANE -H-

5 DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED .15 mm PER SIDE

6 DIMENSION E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED .25 mm PER SIDE

7 DETAIL OF PIN 1 IDENTIFIER IS OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED

8 LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION IS .08 mm IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT

9 THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .10 AND .25 mm FROM THE LEAD TIP

10 ALL DIMENSIONS ARE IN MILLIMETERS

11 THIS OUTLINE CONFORMS TO JEDEC PUBLICATION 95 REGISTRATION MO-153, VARIATION AA, AB-1, AB, AC, AD & AE

SYMBOL	OPTION T1 PGG14T1 JEDEC VARIATION AB-1 MIN	NOM	MAX	NOTE
A	.90	1.10	1.20	
A1	.05	.10	.15	
A2	.80	1.00	1.05	
D	4.90	5.00	5.10	4,5
E	6.20	6.40	6.60	3
E1	4.30	4.40	4.50	4,6
e		.65 BSC		
b	.19	.25	.30	
b1	.19	.22	.25	
c	.09	–	.20	
aaa	–	–	.10	
bbb	–	–	.10	
N		14		

TOLERANCES UNLESS SPECIFIED
DECIMAL ANGULAR
XX± ±
XXX±
XXXX±

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TITLE PG/PGG PACKAGE OUTLINE (PG OR PA TOPMARK CODE) 4.4 mm BODY WIDTH TSSOP .65 mm PITCH

SIZE C | DRAWING No. PSC–4056 | REV 08

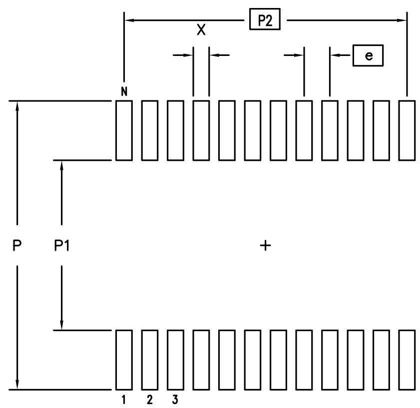
DO NOT SCALE DRAWING | SHEET 2 OF 3

Package Outline and Dimensions (4.4 mm body, 16-TSSOP), cont.

DATE CREATED	REV	DESCRIPTION	AUTHOR
		REVISIONS	
08/25/98	02	ADD 14 & 16 LD	T. VU
07/10/99	03	ADD 8 LD	T. VU
5/23/01	04	ADDED TOPMARK TO TITLE	
10/14/04	05	ADD "GREEN" PGG NOMENCLATURE	TU VU
3/8/13	06	ADDED PACKAGE CODE	RAC
9/3/14	07	ADD TOLERANCE FOR A, A1, E AND b	CK LEE
3/10/17	08	ADD OPTION T1	R.TANH

NOTE: REFER TO DCP FOR OFFICIAL RELEASE DATE

LAND PATTERN DIMENSIONS



	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
P	7.20	7.40	7.20	7.40	7.20	7.40	7.20	7.40	7.20	7.40	7.20	7.40
P1	4.20	4.40	4.20	4.40	4.20	4.40	4.20	4.40	4.20	4.40	4.20	4.40
P2	1.95 BSC		3.90 BSC		4.55 BSC		5.85 BSC		7.15 BSC		8.45 BSC	
X	.30	.50	.30	.50	.30	.50	.30	.50	.30	.50	.30	.50
e	.65 BSC		.65 BSC		.65 BSC		.65 BSC		.65 BSC		.65 BSC	
N	8		14		16		20		24		28	

TOLERANCES UNLESS SPECIFIED
DECIMAL ANGULAR
XX± ±
XXX±
XXXX±

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TITLE PG/PGG PACKAGE OUTLINE
(PG OR PA TOPMARK CODE)
4.4 mm BODY WIDTH TSSOP .65 mm PITCH

SIZE	DRAWING No.	REV
C	PSC-4056	08

DO NOT SCALE DRAWING SHEET 3 OF 3

Ordering Information

Part / Order Number	Marking	Shipping Packaging	Package	Temperature
5V41285PGGI	See Page 10	Tubes	16-pin TSSOP	-40 to +85° C
5V41285PGGI8		Tape and Reel	16-pin TSSOP	-40 to +85° C
5V41285NLGI	See Page 10	Trays	16-pin VFQFPN	-40 to +85° C
5V41285NLGI8		Tape and Reel	16-pin VFQFPN	-40 to +85° C

"G" after the two-letter package code denotes Pb-Free configuration, RoHS compliant.

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Revision History

Rev.	Date	Originator	Description of Change
A	04/03/12	J. Chao	New datasheet; Preliminary initial release.
B	06/05/12	J. Chao	1. Removed references to outputs for Ethernet applications in General Description and Features. 2. Updated pins 1 and 2 in pinout and pin description table from S0:S1 to NC. 3. Removed Output Select table. 4. Removed commercial grade ordering info.
C	06/29/12	J. Chao	1. Under output features, changed to "2 - **100MHz** 0.7V current mode..." 2. Added to the beginning of the CLK1 (pin 10/11) and CLK0 (pin 14/15) descriptions "**100MHz** HCSL..."
D	07/23/12	J. Chao	1. Updated Output Features bullet to include "Non-spread" nomenclature. 2. Added "Low Phase Noise:..." bullet to Features/Benefits. 3. Added "Output Select Table 1". 4. Updated pin 1 & 2 descriptions to remove NC and replace with S0 and S1 respectively. 5. Updated pin descriptions for pins 1 & 2.
E	07/24/12	J. Chao	1. Removed 100MHz selection on the pins 10/11 and 14/15 descriptions, and from the Output Features section. 2. Changed Cycle-to-cycle Jitter max. spec from 100ps to 80ps.
F	10/24/12	J. Chao	Added note to page 1 Features/Benefits section stating "For PCIe Gen3 applications, see the 5V41315"
G	06/10/14	J. Chao	1. Added 16VFQFPN package, tables and all references. 2. Moved to Final.
H	05/08/17	C.P.	Updated package outline drawings and legal disclaimer.

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